Cleanup Progress on High Hazard Legacy Facilities at Sellafield: Pile Fuel Cladding Silo

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ABSTRACT

This facility was constructed in the 1940s as the original dry storage silo for Intermediate Level Waste (ILW) arising from the Windscale Pile Reactors. Subsequently it was used as the main storage facility for all ILW arising from the Sellafield operation. It was operated until it became full and the Magnox Swarf Storage Silos were constructed in the mid 1960s.

A systematic and As Low As Reasonably Practicable (ALARP) risk reduction approach has been adopted at Sellafield to address issues in order of risk magnitude. Prior to being in a position to retrieve stored wastes it has been necessary to improve the overall safety performance of the silo. This has involved installing new fire prevention systems, improving structural integrity, clearing waste from the Transfer Tunnel, and improving overall seismic performance.

A major step towards reducing the overall risk profile of this facility has been to seal the six charge holes in the Transfer Tunnel, that were used for tipping the waste into the silo compartments during operations. This also enabled the silo Transfer Tunnel to be removed.

Overall this work has proved that significant cleanup can be performed safely and successfully, in one of the most hazardous environments at Sellafield.

INTRODUCTION

The Pile Fuel Cladding Silo (Fig. 1.) was originally designed for the dry storage of Intermediate Level Waste (ILW) arising from the Windscale Pile Reactors at Sellafield. The facility was subsequently used as the main storage solution for all ILW arising from the Sellafield operation until the Magnox Swarf Storage Silos were constructed in the mid 1960s.

The tipping of waste into the Pile Fuel Cladding Silo ceased in 1965 and the contents have been left undisturbed since that time. When waste tipping was coming to an end, some difficulty had been encountered with waste becoming trapped on the deflector plates above each waste storage compartment. This prevented full discharge of the waste into the storage compartments and resulted in the build up of waste in the Transfer Tunnel at the top of the silo.

In 1986, the Nuclear Installations Inspectorate (NII) carried out a safety audit of the facility and requested options for the future. They also required that the silo must eventually be emptied and decommissioned.

Fig. 1. Exterior of the pile fuel cladding silo.

RISK REDUCTION STRATEGY

A fully developed Safety Case (fdSC) that relied on the waste contents remaining undisturbed originally covered the facility. The NII accepted that waste disturbance could take place safely if the contents of the silo were maintained under a blanket of inert gas to prevent the risk of a fire within the silo.

In view of the deteriorating condition of the facility, a strategy was developed for progressive improvement to fire resistance, structural integrity, and seismic performance as a precursor to removal of the stored waste. This strategy was based on As Low As Reasonably Practicable (ALARP) principles.

A phased approach to the improvement works was adopted with Phase 1 aimed at addressing the risk of fire. This risk was significantly reduced following the successful commissioning and operation of an argon inerting plant in early 2001. This plant effectively made the atmosphere within silo compartments and Transfer Tunnel inert with argon gas to a level of less than 2% oxygen, and opened up the possibility for waste disturbance for the first time.

PREPARATION FOR PLUGGING THE SIX COMPARTMENT CHARGE HOLES

Following on from Phase 1, the second phase of work commenced. This addressed the issue of structural damage and the preparation for sealing the six compartment charge holes.

One of the major steps towards this was to plug the six charge holes in the Transfer Tunnel, through which the waste had been introduced to the storage compartments. Completion of this work reduced the overall fire risk by separating the compartments. It also allowed the subsequent demolition of the Transfer Tunnel, which was one of the remaining and significant seismic weaknesses of the facility. It had the potential to collapse during a seismic event and damage the main silo structure.

The journey towards plugging the charge holes was complex, and difficult, and was achieved by the team working together and overcoming the difficulties and rationalizing the complexities. Everybody played their part in the team, operators, maintainers, contractors, designers, safety case producers, constructors, commissioners, and many others.

In order to achieve the objective of plugging the charge holes and subsequent tunnel demolition, a number of enabling works were required as follows:

- The East Tower needed to be refurbished and structurally improved to enable access to the Transfer Tunnel roof.

- The East Tower Penthouse needed to be stripped of redundant equipment, the cladding on the tower was replaced, new lifting beams and hoists were installed, and load bearing covers and transfer bogeys were installed to safely transfer equipment.

- In preparation for sealing the charge holes, new ventilation connections had to be drilled into the roof of each waste compartment. These had to be connected to new pressure protection lutes and into the existing ventilation extract ducting to enable argon to be drawn directly from each compartment.

- The antechamber of the Transfer Tunnel had to be refurbished and modified. Redundant bogeys and contaminated equipment were removed. New oxygen monitoring equipment and a new interlocked pressure-retaining door were installed. The bulkhead into the Transfer Tunnel was then removed.

Then the waste that had remained in the tunnel since the 1960s had to be cleared (Fig. 2.). A waste clearance method was conceived initially to poke the waste back into the storage compartments. It was subsequently developed and equipped with hydraulic cutters to chop up scaffolding and steel covers that also resided within the tunnel. This simple but effective method cleared all of the bulk waste, scaffolding, and residual material into the compartments (Fig. 3.).

Fig. 2. Waste protruding above the compartment charge holes within the transfer tunnel.

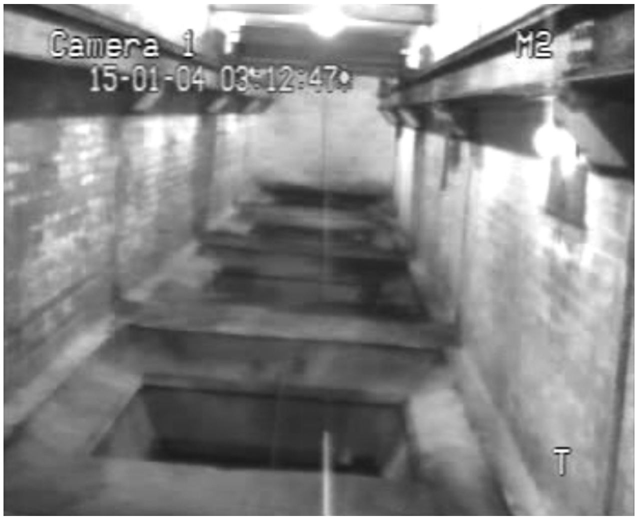

Fig. 3. View inside the transfer tunnel upon completion of waste clearance work.

PLUGGING THE SIX COMPARTMENT CHARGE HOLES

The installation of the charge hole sealing equipment required human access into the Transfer Tunnel and would expose people to high radiation doses, the potential to fall into the storage compartments, and an asphyxiation risk from the argon. This work had to be carried out while the waste within the compartments was inert under a blanket of argon at all times. Strategies to manage and overcome these issues were developed and trialed off-site in a low hazard simulation. The plans and actions were developed and refined, leading to all personnel who would take part in the plugging task becoming fully trained and well practiced in all planned operations. Emergency and evacuation procedures were also firmly established and rehearsed.

Initial entry into the Transfer Tunnel revealed that the floor of the tunnel was in a worse condition than had been envisaged. Heavily corroded liners, loose or missing grouting, and widespread contamination resulted in a major cleaning and repair exercise prior to installing the main plugging frames. The first stage trays were installed before this cleaning to remove the fall potential and improve the radiation shielding and argon retention. To provide a base seal, workers painted a two-stage membrane on the tunnel floor upon completion of cleaning.

The main seal arrangements were then installed over a one-month period. During this time, commissioning tests were carried out and the sealing arrangements of the compartments were progressively improved. This minimized the air in-leakage into the silo, thus maintaining oxygen concentrations within acceptable limits.

DEMOLITION OF THE TRANSFER TUNNEL

Following successful completion of the plugging task, the preparatory works for demolition were implemented. This comprised the isolation and strip out of redundant tunnel monitoring and alarm systems, ventilation, and mechanical equipment. Natural ventilation of the tunnel was established by drilling circular openings in the tunnel walls. The tunnel doors and antechamber roller shutter door were removed. A temporary works scheme for installation of lower and intermediate demolition platforms was implemented.

On completion of the preparatory work, the removal of the tunnel roof and antechamber commenced. The method employed was to use a diamond drill to create openings in the roof. This then allowed access for hydraulic crunchers to break up and remove large concrete lumps of the tunnel roof. All demolition waste had to be bagged and winched down to ground level for discharge into containers for transfer to the Low-level Waste Repository at Drigg.

Following complete removal of the tunnel roof, the tunnel walls were then demolished to the specified level. The remaining low-level walls were then made good and a weatherproof cap was installed and supported upon them (Fig. 4).

The most recent achievement has been to install a new argon plant for the silo, to improve the assessed reliability of the inerting system and to provide a seismically qualified argon supply to the silo, the previous works having completed the seismic qualification of the silo itself. The new plant consists of two argon vaporizers and a 34-ton storage tank, all located on a seismically isolated, double-layer reinforced concrete slab. Commissioning of the new plant will commence later in 2006.

The route for the supply pipe-work runs through four large pits before crossing over a site service trench on a bailey bridge and was created using a massive Thrust Boring machine. Similar to a large corkscrew, this was used to bore underground, creating the route for supply pipe-work.

This phase of the work has been accelerated into the program from 2007, when it was due to be carried out under the approved Near Term Work Plan, following approval of an acceleration change request by the Nuclear Decommissioning Authority (NDA).

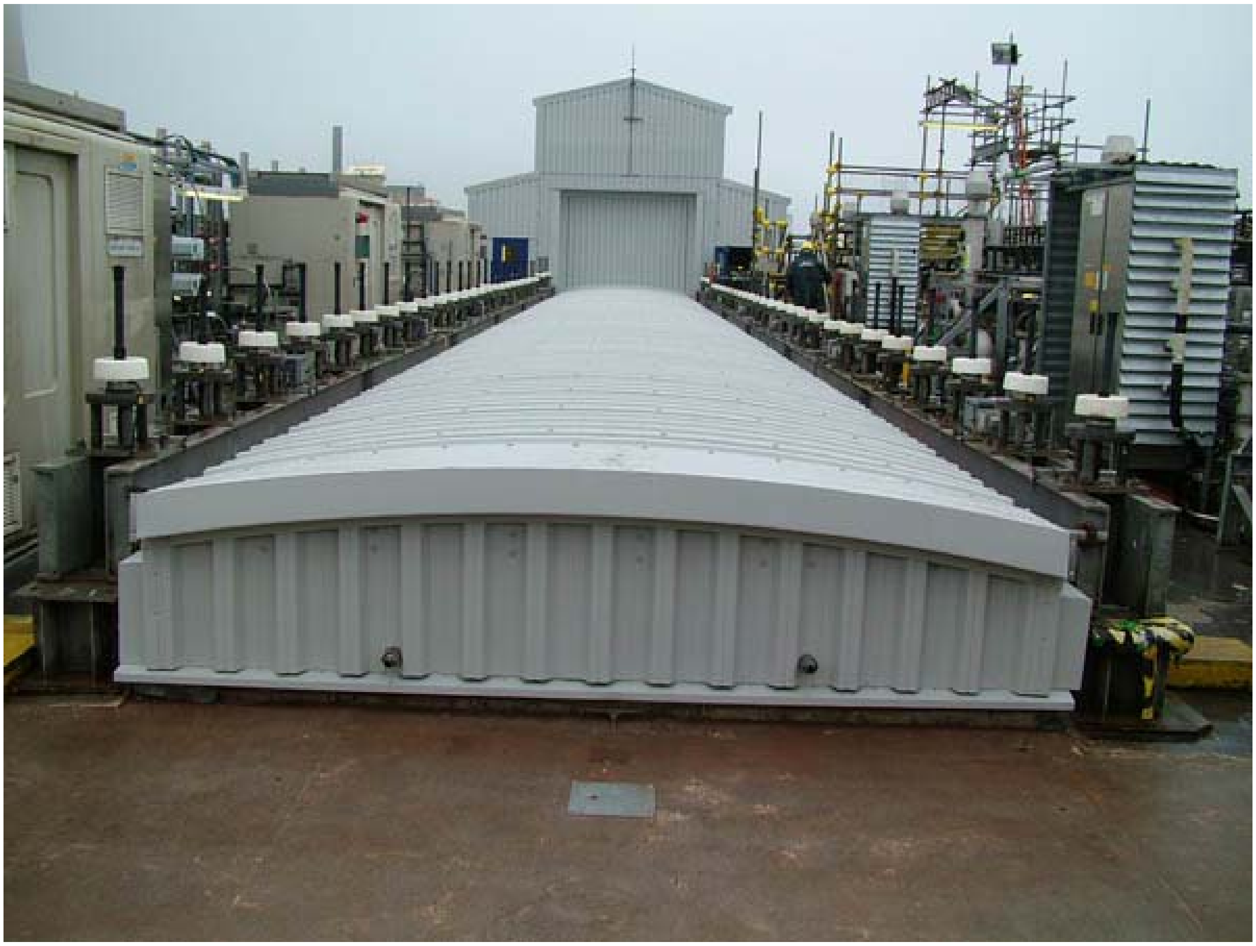

Fig. 4. View following total demolition and capping of the Transfer Tunnel

CONCLUSION

The Pile Fuel Cladding Silo is the oldest purpose-built waste store at Sellafield. It represents one of the most hazardous and challenging environments associated with the British nuclear legacy. This fact ensures the silo continues to rank high our agenda, and those of our customer and regulators. The success of this project has proved that British Nuclear Group can effectively manage their own teams, along with those supplied by subcontractors, to deliver in harmony against common project goals that are flawlessly executed.

Since the starting position in 1996 the risk posed by the silo has been systematically reduced one hundredfold. The main work packages, like charge hole plugging and tunnel demolition, have been accelerated by three years compared to the reference program. British Nuclear Group will continue to manage the silo effectively through the remaining retrieval and decommissioning phases and has recently selected the technique for retrieving the bulk waste from the silo, which is now in the early stages of design.